BOOK REVIEWS

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Vegetation and the Terrestrial Carbon Cycle: Modelling the First 400 Million Years

David J. Beerling and F. Ian Woodward. Cambridge University Press, NY. 405 pp., cloth. 2001.
[ISBN 0-521-80196-6]

As the title suggests, this book synthesizes years of work predicting carbon dynamics over geological time scales. This was not a trivial effort, since even monthly or yearly simulations are fraught with uncertainty and viewed with trepidation. Beerling and Woodward's goal was to develop a fundamentally sound model of plant response to environmental conditions (primarily atmospheric CO_2 concentration and moisture availability) translatable across spatiotemporal scales to yield global estimates of paleovegetation. To do this, the process of photosynthesis was assumed to be similar over evolutionary time within functional groups. If this model proves reliable over the >400 million year history of terrestrial vegetation, the authors believe it could help explore the implications of future atmospheric CO_2 enrichment and related climate change.

The first chapter describes applicable time scales and geological periods, including their significant biological and climatological features. Chapter 2 focuses on the evolutionary biochemistry related to the vegetation model. The slow rate (<1% every 20 million years) of rubisco mutation implies that modern photosynthesis behaves very similarly to the process as of 400 million years ago (mya). Stable carbon isotope ratios expressed by intercellular discrimination of CO_2 suggest that carboxylation and oxygenation in modern and paleovegetation are also virtually identical. Hence, understanding contemporary terrestrial photosynthesis allows for the prediction of past (and, presumably, future) response when coupled with simulations of atmospheric CO_2 levels and available moisture. Chapter 3 further elaborates on this simple yet profound design by focusing on the boundaries of acceptable climates for terrestrial vegetation. Chapter 4 introduces general circulation models (GCMs) that provide the climate inputs. This chapter also describes the Sheffield Dynamic Global Vegetation Model, plant functional groups (e.g., evergreen broadleaved trees), and parameterizations based on different GCMs. When integrated, these components produce the system used to predict past and future vegetation patterns.

Chapters 5 through 9 simulate carbon dynamics for noteworthy periods in the history of the earth, including the Carboniferous (300 mya), Jurassic (150 mya), Cretaceous (100 and 66 mya), Eocene (50 mya), and the Quaternary (0.021 and 0.006 mya). These periods were selected for their interesting atmospheric CO_2 and O_2 levels, unique continental configurations, and adequate fossil evidence for model validation. Model predictions corresponded reasonably well with the available geological records, although areas of notable departure could be found. Chapter 10 brings the simulations to a close by evaluating the potential of the system to assess future global vegetation conditions. The authors did not dwell on the scenarios of human-induced climate change, preferring instead to run limited simulations that supported other contemporary projections. Chapter 11 summarizes the earlier results but does not provide any grand vision of the past, present, or future, as may be desired.

This book is generally well written and understandable, especially given the subject matter. A glossary of the more technical terms would have helped those unfamiliar with the jargon of paleomodeling. As an example, the term "Milankovitch orbital insolation" is used on page 6 without any definition. Some of the figures were hard to interpret because of faint lines, indistinct data points, or small/obscure legends. It was easy to get lost in the many maps of vegetation distribution and C storage, but their captions were generally helpful. I found a couple of simple math errors that apparently escaped review. These errors probably did not affect the authors' interpretations but were unexpected given the mathematical emphasis of the book. Objectively evaluating the model outcomes was challenging. Some measure of error or variance in the figures and tables was needed to indicate the relative confidence in their predictions.

The overall effectiveness of this approach was deemed good by the authors, although some of their assumptions were questionable. For example, Beerling and Woodward (p. 44) state: "these simulations are for undivided, well-illuminated leaves, with no limitations due to nutrient and water supply." This abstract photosynthetic surface is rarely found in any terrestrial environment, and would poorly explain the behavior of any given plant. How this particular assumption translates to global scales is even more disputable. Chapters 5 through 9 also highlight the degree of input data uncertainty, which concerned even the authors. This makes one question why some specific events (e.g., widespread fire in the late Carboniferous [Chapter 5] and the Cretaceous K/T impact [Chapter 7]) were simulated when there was only limited assessment of larger scales. Nevertheless, the model system described seems fundamentally reasonable even if some of questions about the assumption validity remain (this is true of any model).

For those unaccustomed to large-scale models, the use of GCMs approximated to only a few degrees of latitude and longitude or the consideration of plant functional groups rather than species of populations will seem woefully inadequate. Others may find Beerling and Woodward's attitude toward global climate change uncomfortably nonchalant. Given the dire warnings of increasing atmospheric CO_2, a model that highlights positive plant productivity over such a coarse scale may be interpreted by some as a tool of laissez-

faire capitalism. I don't think this is what the authors intended. Rather, their geological perspective of global climate change implies that such alterations, even if lethal to many species, are not necessarily calamitous for vegetation in general. There have been many events throughout time that have been at least as rapid and pronounced as anthropogenic global warming, and plant life has shown remarkable tolerance of them. This, of course, is little comfort to those trying to preserve remnants of sensitive species.

The almost unfathomable spatial context of this book seems antithetical to the limited extent of most natural areas. Also, readers unaccustomed to thinking across geological time scales may be challenged. For instance, the authors characterized the passage of 130 million years of evolution from the first tiny vascular plant *Cooksonia* to the massive *Lepidodendron* as "very rapid." However, those interested in the factors that determine terrestrial vegetation should find value in this work, even if only posed as abstract questions. What environmental changes may be expected if the current atmospheric CO_2 increase and moisture levels deviate from recent trends? How rapidly can plant functional groups respond to this change? How will the rare C_4 grasses currently protected in my natural area fare under changing atmospheric conditions?

I would recommend this book for those interested in a better understanding of large-scale simulation and the integration of GCMs with terrestrial vegetation models. Having a model-receptive mind will make the text more accessible, and those who appreciate the biophysical foundations of models will benefit considerably from this state-of-the-art paleosimulator.

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Wilderness Comes Home: Rewilding the Northeast
C. M. Klyza, ed. University Press of New England, Hanover, N.H. 320 pp., paper. 2001.
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What is wilderness? Is it exclusively those lands legislatively designated as wilderness under the Wilderness Act, places that remain untrammeled by humans? Or does wilderness exist outside of the federal proclamation boundaries, wherever we find natural areas so vast that we feel small and insignificant? Aldo Leopold, one of the original founders of The Wilderness Society, adopted the narrow view. Wilderness, to Leopold, is a resource that diminishes over time and requires permanent protection if it is not to be lost entirely.

Christopher Klyza and company ascribe to a different view. They explore the meaning of wilderness in the northeastern United States, a region that was an agricultural landscape just over a century ago, where nearly all of the forests there have been cut at least once, and where more than 85% of the land is privately owned. This book is not about the popularized wilderness of the Arctic tundra, the southwestern desert, the Rockies, or the Cascades. It concerns a wilderness that seems intent upon returning to the New England landscape whence it was banished by the axe and plow.

The edited volume is divided into three parts. Part I, "Taking Stock," serves as a survey of wilderness in the Northeast at the beginning of the twenty-first century. Here, we take stock philosophically, historically, ecologically, and politically. In the opening chapter, Klyza argues that our concept of wilderness should depend on context. The eastern United States has a history of more intense and more widespread land use, and considerably less federal land than the western United States. Instead of designating federal wilderness in the East, our focus should be on ensuring that some lands remain unmanaged.

Klyza echoes Wendell Berry's argument that we can not successfully restore wilderness without creating viable models of sustainable agriculture, sustainable forestry, and sustainable rural communities. With wilderness restoration already underway in the Northeast, we can choose the laissez faire approach and see what kind of landscape ultimately results, or we can put both hands on the steering wheel, consult the map to our intended destination, and drive. This theme recurs throughout the book. The remaining chapters in Part I are extensions of the historic (Daniel and Hanson), ecological (Leverett), and political (Klyza) themes of the opening chapter.

Part II, "Designing a System of Northeastern Wild Lands," examines some of the elements of reserve design as applied in the Northeast. Steve Trombulak's opening chapter serves as a brief review of the history and theory of reserve design, and highlights six wildlands initiatives already underway in the region. In a chapter that is both provocative and compelling, Jamie Sayen develops a vision of large-scale wilderness recovery, including a 3.25 million ha Headwaters Wilderness Reserve System in an area that lacks any year-round residents. Remaining chapters on species reintroduction (Trombulak and Royar) and acquiring lands through purchase and easement (Bateson and Smith) round out Part II.

Part III, "Northeastern Wild Lands in Context," considers how to better integrate nature and culture. It is here that we see an extended notion of wilderness emerge; one which views preservation and stewardship as two sides of the same conservation coin. The opening chapter by Nora Mitchell and Rolf Diamant discusses conservation in the "middle landscape:" lands that retain wild features despite having a long history of human use. Next comes a chapter on family forests and the grassroots initiatives to promote better stewardship on these lands (Brynn). The remaining chapters (Elder, Davis) contemplate how the integration of unmanaged and managed lands into a single conservation focus might benefit or undermine the conservation movement. A brief but engaging epilogue by Bill McKibben closes the book.

I liked this book for a couple of reasons.